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Physical Fitness of Men Entering The Army Air Forces

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IN 1943 with an ever-increasing number of men entering the Army Air Forces, there was need for an evaluation of the physical status of these men at the time of their entrance into the service. It was felt that such information would be helpful in making the Army Air Forces (AAF) physical training program more efficient. Emphasis in the program could then be placed on activities benefiting those body parts that were found to be lacking in strength and endurance. Also, the performance records gathered for this study could be compared with those observed in later stages of training for an estimation of the amount of improvement due to the AAF physical training program.

PROCEDURE

Since physical training for AAF enlisted personnel and aircrew trainees started at the AAF Basic Training Center (BTC), seven BTC's which were located at widely separated points throughout the country were selected for this study. They were Jefferson Barracks, Missouri; Sheppard Field, Texas; Miami Beach, Florida; Lincoln, Nebraska; Buckley Field, Colorado; Greensboro, North Carolina; and Amarillo, Texas.

AAF physical fitness test* scores were collected at these installations on 4,172 enlisted men and aircrew trainees, ranging in age from 18 to 40, who had less than one month of service in the Army.

According to regulations, the AAF physical fitness test should have been given during the first two weeks of basic training. Because of scheduling difficulties, however, it was found that the testing sometimes was delayed until the third or fourth week of training. In order to obtain a sufficient number of cases, the scores of men tested during their first four weeks of training were used, these men being considered entering AAF personnel. Data on aircrew trainees who had been in the service as enlisted men before being sent to the Basic Training Center were not used. Care was taken to make

* The AAF physical fitness test consists of three test items: sit-ups, pull-ups, and 300 yard shuttle-run. The Physical Fitness Rating (PFR), calculated from the scores of the three test items, is used as an index of fitness.

certain that the testing at these installations was carried out in accordance with the official AAF regulations.[2]*

RESULTS

The test scores from all of the seven installations were pooled and distribution histograms were prepared for the three test items and the physical fitness rating (Figure 1**). Tests for the normality of the curves revealed that for sit-ups and pull-ups the curves are skewed to the right and peaked, the shuttle-run curve is skewed to the right and flat-topped, and the PFR curve is skewed to the left and peaked. Although these deviations are statistically significant, it should be noted that the threshold of significance has been greatly lowered by the large number of cases used in the study, and that by observation the histograms do not appear to deviate from normal to any great extent. Records of a few of the men whose scores differed greatly from the group were not used on the ground that they were rare extremes.

The means for the test items are: 34.1 ± .22 sit-ups; 6.0 ± .05 pull-ups; 56.3 ± .08 seconds in the shuttle-run; and 44.5 ± .15 for the PFR. The means, their standard errors, and standard deviations of the test items are listed in Table I. The percent of subjects who scored in each of the classifications of the AAF physical fitness test achievement scales is given in Table II. A comparison of the three test items is more striking if the excellent and very good groups in Table II are combined to represent the upper level of performance, and the poor and very poor groups are combined to represent the lower level of performance. When this is done, it may be seen that for the pull-ups only 4.8 percent of the men scored in the upper level of the scale, and 68.9 percent scored in the lower level of the scale. For sit-ups 9.2 percent scored in the upper level, and 57.2 percent scored in the lower level. For the shuttle-run 14.3 percent scored in the upper level, and 52.9 percent scored in the lower level. From this analysis it is apparent that the men, as a group, did not score well in any of the three test items, and that they gave the poorest performance in the pull-ups.

A more detailed analysis of the scores was made by calculating means at one-year age intervals for each of the test items and the PFR as shown in Table III. Also shown in Table III are the scores that may be expected from the entering AAF personnel at the various age levels on the basis of a linear relationship between score and age. The assumption of linearity was made from an inspection of the plotted mean scores. This relationship between age and the AAF physical fitness test had been established in a previous study.[1]

* Superior figures refer to numbered bibliography at end of article.

** Figures 1 and 2 will be found on pages 188-191.

TABLE I

TABLE OF MEANS FOR AAF ENTERING PERSONNEL

	Sit-ups	*Pull-ups*	*Shuttle-run*	*PFR*
Mean	34.1	6.0	56.3	44.5
Standard Error	± .22	± .05	± .08	± .15
Standard Deviation	14.32	2.98	5.35	9.72

TABLE II

PER CENT OF SUBJECTS AND THEIR CLASSIFICATION ACCORDIND TO THE AAF PHYSICAL FITNESS TEST ACHIEVEMENT SCALES

Score	*Sit-ups*		*Pull-ups*		*Shuttle-run*		*PFR*
Excellent	2.1%	9.2	0.5%	4.8	1.3%	14.3	0.2%
Very Good	7.1		4.3		13.0		3.6
Good	33.7		26.3		32.8		48.2
Poor	47.3	57.2	47.7	68.9	39.0	52.9	36.8
Very Poor	9.9		21.2		13.9		11.2

The expected scores were computed using the linear regression formula $Y = \bar{y} \pm b\ (x - \bar{x})$, where Y is the expected score, $\bar{y}$ is the grand mean of the scores, b is the regression coefficient, $\bar{x}$ is any age level, and $\bar{x}$ is the mean age.

The regression lines which run through the points plotted for the expected scores are shown in Figure 2. The distribution of the mean scores and the grand mean for each test item are also shown. The data for ages 39 and 40 were not included because of the small number of cases for those age groups.

At the foot of Table III is given the linear regression coefficient for each test item.

INTERPRETATION

The grand mean scores for the pull-ups and the shuttle-run fall into the upper end of the "poor" classification of the official AAF testing score card. The grand mean score for sit-ups falls into the lower end of the "good" classification.

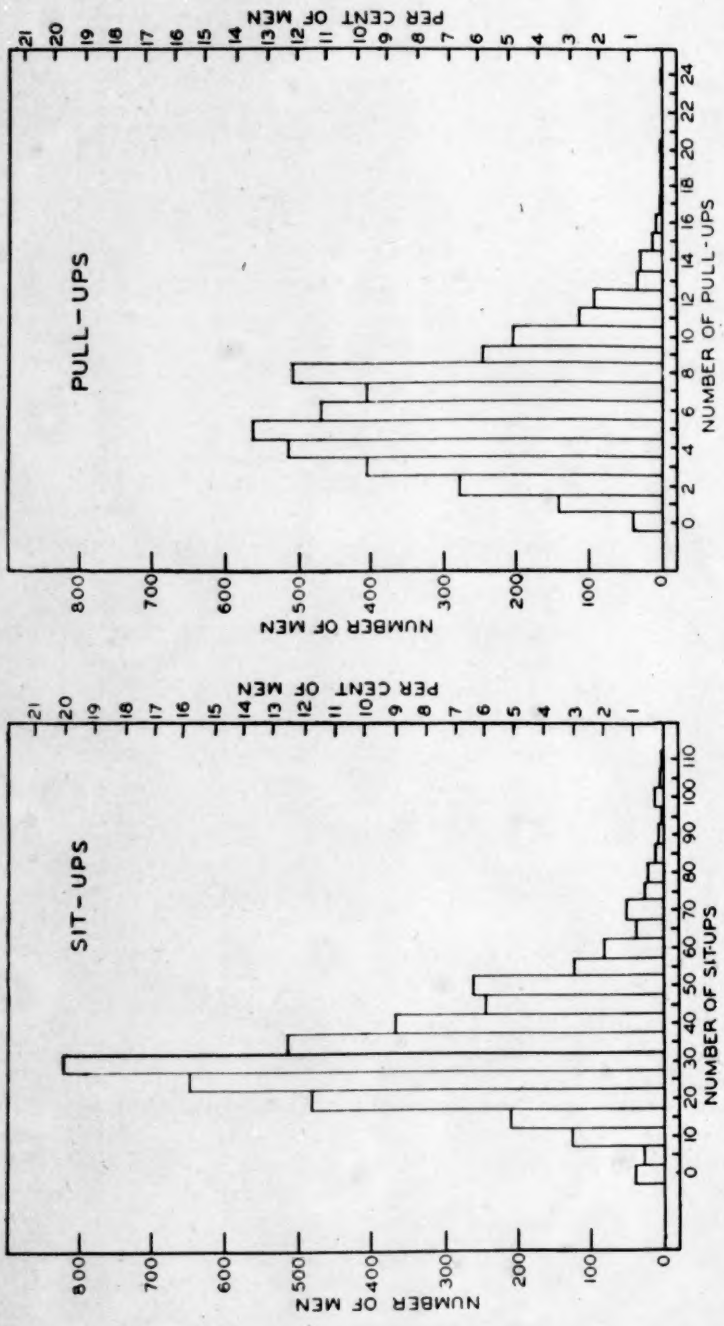
The mean scores for the physical fitness rating for all ages range from 34.0 to 47.4 with a grand mean score that falls in the upper end of the "poor" classification.

TABLE III

AAF ENTERING PERSONNEL PHYSICAL FITNESS TEST SCORES

Sit-ups				Pull-ups				Shuttle-run				PFR			
Age	No. Men	Mean Score	Expected Score	Age	No. Men	Mean Score	Expected Score	Age	No. Men	Mean Score	Expected Score	Age	No. Men	Mean Score	Expected Score
18	477	37.3	39.5	18	483	5.7	6.6	18	478	53.9	54.0	18	483	47.4	49.3
19	293	39.9	38.8	19	298	6.4	6.5	19	297	54.8	54.3	19	298	48.3	48.6
20	275	38.5	38.1	20	282	6.4	6.4	20	279	54.6	54.7	20	282	48.7	48.0
21	337	37.8	37.3	21	340	6.6	6.3	21	336	54.8	55.0	21	340	47.6	47.4
22	266	37.5	36.6	22	269	6.7	6.3	22	264	54.8	55.3	22	269	48.1	46.7
23	212	35.2	35.9	23	212	6.5	6.2	23	207	55.5	55.6	23	212	46.3	46.1
24	231	36.5	35.2	24	231	6.6	6.1	24	226	55.6	55.9	24	231	46.1	45.5
25	223	35.8	34.5	25	226	6.3	6.1	25	222	56.5	56.2	25	226	45.9	44.8
26	205	35.2	33.8	26	206	6.1	6.0	26	201	57.0	56.5	26	206	44.7	44.2
27	172	33.7	33.1	27	172	6.3	5.9	27	165	56.8	56.9	27	172	44.3	43.6
28	124	30.8	32.4	28	124	6.2	5.8	28	120	58.3	57.2	28	124	42.6	42.9
29	143	33.5	31.7	29	143	6.4	5.8	29	132	58.2	57.5	29	143	43.3	42.3
30	161	29.9	31.0	30	163	5.4	5.7	30	146	58.2	57.8	30	163	40.4	41.7
31	152	31.5	30.0	31	152	5.4	5.6	31	142	58.2	58.1	31	152	41.3	41.0
32	133	28.7	29.5	32	134	5.5	5.5	32	124	57.6	58.4	32	134	41.0	40.4
33	141	26.6	28.8	33	141	5.2	5.5	33	130	59.4	58.8	33	141	38.5	39.8
34	130	25.4	28.1	34	132	5.3	5.4	34	116	58.6	59.1	34	132	38.5	39.1
35	125	27.2	27.4	35	125	4.9	5.3	35	112	59.7	59.4	35	125	37.6	38.5
36	166	29.3	26.7	36	166	5.3	5.3	36	140	58.8	59.7	36	166	39.3	37.9
37	123	24.8	26.0	37	123	4.5	5.2	37	99	59.7	60.0	37	123	35.2	37.2
38	43	24.2	25.3	38	41	4.8	5.1	38	36	60.5	60.3	38	43	34.5	36.6
39	4	18.5	24.6	39	4	5.3	5.0	39	3	60.3	60.6	39	4	34.7	35.9
40	3	24.4	23.9	40	3	5.3	5.0	40	2	62.5	61.0	40	3	34.0	35.3

	Regression Coefficient		Regression Coefficient
Sit-ups	—0.71	Shuttle-run	+0.32
Pull-ups	—0.07	PFR	—0.63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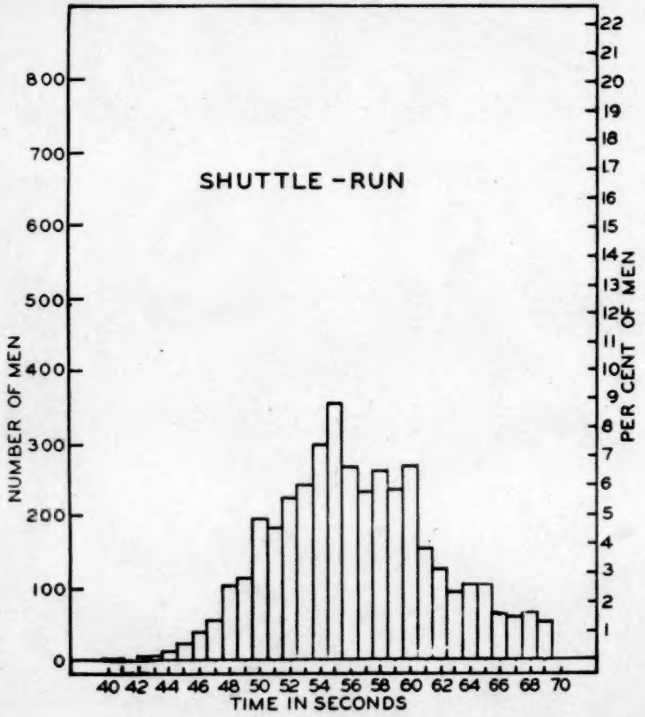


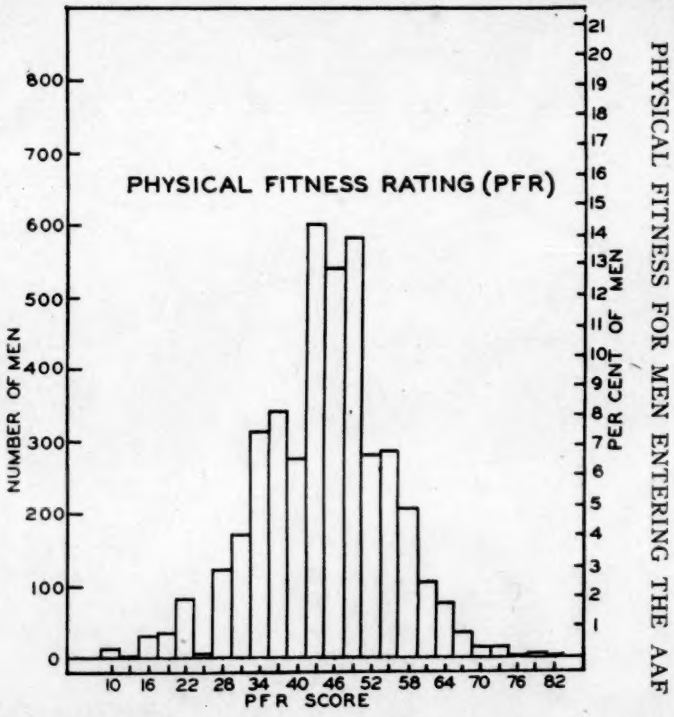
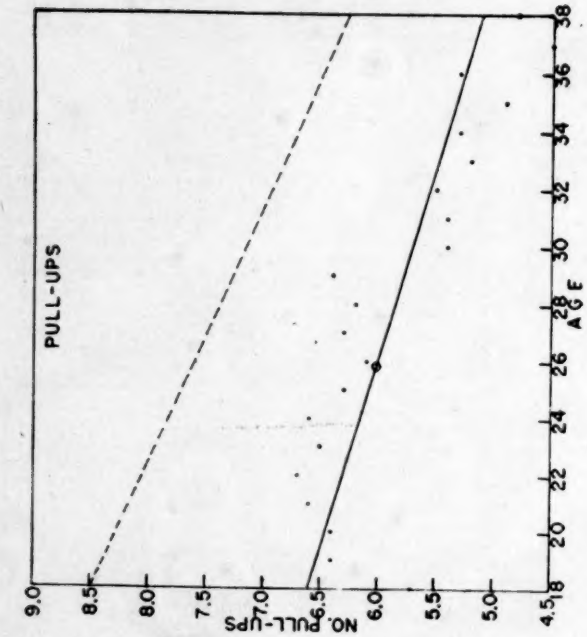


Figure 1 (both pages). Distribution of Scores in the AAF Physical Fitness Test for Men Entering the Army Air Forces.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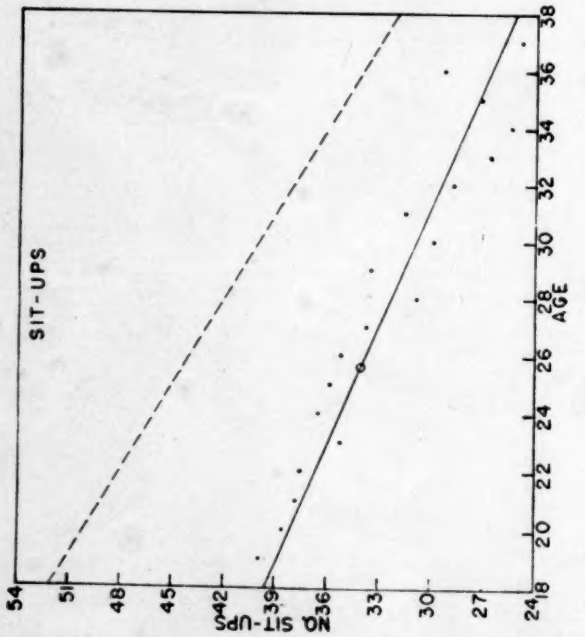
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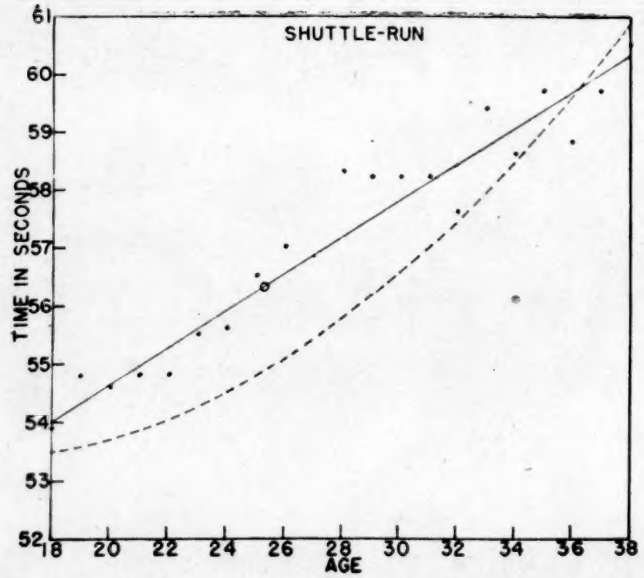

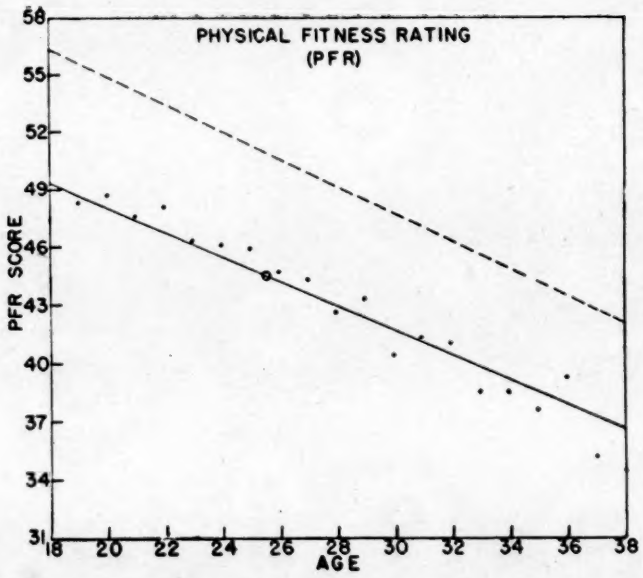

Figure 2 (both pages). Relationship Between Age and Physical Fitness for Entering and for Training AAF Personnel. Legend: ——— Entering Personnel; ..... Personnel Averaging 21.5 Weeks of Training; • Mean Score; O Grand Mean.

The scores obtained in this study were graphically compared with those of men studied elsewhere[1] in later stages of training as shown in Figure 2 in order to determine how much an entering group differed from that which had been participating in the AAF physical training program. This second group consisted of 10,280 men who had been in AAF training schools for a period of time averaging 21.5 weeks. The graphs in Figure 2 show that for each test item the entering personnel scored consistently lower than the trained men.

CONCLUSIONS

On the basis of the AAF physical fitness test scores, it may be concluded that enlisted and aircrew personnel entered the Army Air Forces in fairly poor condition.

The men were found to be lacking in running speed and endurance, and endurance of the abdominal muscles, but were most deficient in arm and shoulder strength.

The mean scores of the entering personnel were 34.1 sit-ups, 6.0 pull-ups, 56.3 seconds in the shuttle-run, and 44.5 for the physical fitness rating.

At all age levels, and for all test items, entering personnel scored lower than men who averaged 21.5 weeks of training in the AAF.

BIBLIOGRAPHY

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[2]*Training, Physical Fitness Test, AAF Regulation No.* 50-10. Washington, D. C.: Headquarters, Army Air Forces, April 28, 1943.

The Relationship of Recreational Participation To Industrial Efficiency

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INTRODUCTION

DURING the past decade the emphasis placed on industrial recreation, in terms of number and scope of programs, has increased to a great extent. This rapidly growing phase of personnel management owes its rise to several reasons. Some of them are listed below.

1. The increasing appreciation of values inherent for improved employee-employer relations.
2. The fact that industrial recreation offers a release from nervous tensions that are concurrent with present-day assembly line production.
3. The more recent belief that there is a positive relationship between a progressive program of recreation within industry and the industrial efficiency of those organizations. It is the intent of this study to concern itself with an analysis of this relationship.

PROBLEM

The general problem was to determine the degree of relationship between the participation of men employees in recreational activities and ratings of their industrial efficiency.

The following sub-problems were involved in the problem:

1. Determination of the degree of relationship between "active" recreational participation and industrial efficiency.
2. Determination of the degree of relationship between "passive" recreational participation and success on the job.
3. Determination of the degree of relationship between the number of different recreational activities that an employee takes part in and the amount of success that he experiences on his particular job.
4. The determination of the relationship between specific recreational activities and industrial efficiency.

PROCEDURE

This study was completed at Servel, Inc., Evansville, Indiana, during December of 1945.

Activity Invoice.—A questionnaire was developed, the purpose of which was to measure the time that each employee was engaged in any type of leisure-time activity. This questionnaire was given the name of Activity Invoice.

This is an abstract of a thesis prepared in partial requirement of the degree of Master of Arts, Purdue University, Lafayette, Indiana, 1946.

Seventy-one recreational activities were listed on the Activity Invoice. At the conclusion of the list was left a space into which the individual was invited to write any other leisure-time activities in which he engaged.

The column opposite the list of activities provided a space for the employee to record the amount of time that he spent in recreational activities in terms of hours per day, days per month, and months per year. When the hours, days, and months were multiplied together the product was the number of hours per year that the employee took part in that activity. The sum of the individual activity participation hours provided the total number of hours per year the employee spent in recreational activities.

In treating the results of the Activity Invoice, the activities were arbitrarily divided into two classifications, "active" and "passive." The "active" group included:

archery
badminton
baseball
basketball
billiards
bicycling
boating or canoeing
bowling
boxing
camping
club or hobby
craftwork
dancing
dart throwing
fencing
flying
gardening
golf
gymnastics and tumbling
handball
hiking
horseback riding
horseshoes
hunting
fishing
ice skating
ice hockey
picnicking
ping pong
rifle shooting
pistol shooting
roller skating
skeet shooting
skiing
soccer
softball
squash
shuffleboard
swimming and diving
tennis
tobogganning
touchball
track and field
volleyball
washers
weight lifting
wrestling

The "passive" group included:

art
banquets, teas, and suppers
bingo and card parties
chess and checkers
clabber
cribbage and dominoes
debate
dramatics
attending movies or theaters
newspaper staff work
reading magazines, newspapers, or books
sightseeing or pleasure driving
smokers
social parties
attending lectures and concerts
attending circuses and amusement parks
playing poker

The classification of these activities is quite arbitrary and subject to question, but it was the writer's opinion that such a classification would make it possible for an employee who was nearing the age of fifty years to be able to take part in about as many "active" activities as would the younger employees.

Superintendents' Rating.—In order to make the study meaningful, it was imperative that a valid measurement of industrial efficiency be utilized. In the absence of suitable objective measurements it was decided to use the superintendents' judgment as that measurement of industrial efficiency. At face value this measurement is practically one hundred per cent valid because it is the superintendent's judgment which determines the employee's tenure and monetary remuneration, discounting such factors as seniority rules and legislation.

Seven superintendents of the major production divisions of Servel were contacted and each was asked to list his five "best" and five "poorest" workers, considering only the value of the worker to his particular job.

Each employee who was selected by his superintendent as being either "best" or "poorest" was required to fill out the Activity Invoice. It must be emphasized that both the "best" and the "poorest" employees were given the same instructions and neither group was aware that they had been selected because of their work on the job. They were not told that the results of their Activity Invoice would be compared with their industrial efficiency. They were told only that they had been selected as one of a sample group the members of which had been asked to fill out the questionnaire.

Statistical Procedure.—When the completed questionnaires were returned, conventional statistical procedures were employed to determine if there were significant differences between the two groups in terms of the various aspects of their recreational habits. The statistical tools which were employed were means, standard error of percentages, standard deviations, and critical ratios.

RESULTS OF COMPARISON OF SUPERINTENDENTS' RATING WITH RESULTS OF ACTIVITY INVOICE

These are the results of the study of 72 male workers at Servel, Inc., all of whom were employed in seven major production divisions of that organization. Each of these production divisions employed at least 150 persons.

Each of the 72 employees with whom this study is concerned was selected by his superintendent as being either one of the five best or one of the five poorest employees in his division. The selections were made solely on the basis of the employee's value to his particular job.

These ratings do not imply that the employee in question is actually good or actually poor. The ratings only imply that the employee is better or poorer than the majority of the other employees in his department. Several of the superintendents stated that they really did not have five employees who were actually poor. The same might have been true of the best employees. One must keep in mind that "best" and "poorest" are not concrete descriptions of the em-

ployee's efficiency. These terms tell one only that the employee is either inferior or superior to the majority of his fellow workers.

SIGNIFICANCE RATIOS OF THE DIFFERENCES BETWEEN THE "ACTIVE" RECREATIONAL PARTICIPATION OF THE 36 POOREST AND 36 BEST EMPLOYEES

Number of Active Recreational Activities Per Year.—The results of the Activity Invoice of the 36 best workers showed that they took part in an average (mean) of 4.9 active-type recreational activities during one year. This number was 1.51 *more* active activities than was the average of the poorest group. The poorest group's average number of active recreational activities per year was only 3.39 as compared to 4.9.

This difference (1.51) has a T value (significance ratio) of 2.18. Using 72 cases, a T value of this proportion (2.18) is significant at the 5 percent level of confidence. This means that, using a sample comparable to this one, a difference means would be obtained more than 95 times out of each 100 times that such a sample was surveyed.

Hours Per Year of Active Recreational Participation.—The results of the Activity Invoice indicate that the employees who were rated as being the best in their division took part in significantly more hours of active recreation than did the employees who were rated as being poorest. The poorest employees averaged 230 hours of active recreational participation per year, while the best workers participated in 392 active hours of recreation during the same year. This difference (161.8 hours) is significant at the 2 percent level of confidence.

SIGNIFICANCE RATIOS OF THE DIFFERENCES BETWEEN THE "PASSIVE" RECREATIONAL PARTICIPATION OF THE 36 POOREST AND 36 BEST EMPLOYEES

Number of Passive Recreational Activities Taken Part in During One Year.—The Activity Invoice of the 36 best workers showed that they participated in an average of 3.9 passive-type recreational activities during a one-year period. The poorest group averaged 2.5 passive recreational activities for the same one-year period. This is a difference of 1.4 recreational activities between the two groups during the year studied.

This difference (1.4) has a T value of 2.868 which indicates, in this case, that there is less than one chance in one hundred that a difference between the means of the two groups would be obtained by chance alone.

Hours Per Year of Passive Recreational Participation.—The employees who were rated by their superintendents as being in the best group spent 523.36 hours per year participating in passive types of recreation. This was 205.78 hours per year more than was spent

by the group which was rated by their superintendents as being poorest (317.58).

This difference (205.78 hours per year) has a significance ratio of 2.6586. A *T* value of this magnitude (2.6586), obtained from 72 cases, would indicate that a difference between the two means would be the result of chance factors alone less than once out of each one hundred times a comparable survey was made.

The results of this phase of the study strongly indicate that there is also a positive relationship between hours of passive recreational participation and industrial efficiency.

SIGNIFICANCE RATIOS OF THE DIFFERENCES BETWEEN THE TOTAL RECREATIONAL PARTICIPATION OF THE 36 POOREST AND 36 BEST EMPLOYEES

Number of Recreational Activities Per Year.—As recorded on the Activity Invoice, the group of best workers participated in a mean average of 8.8 different recreational activities per year. The poorest group's mean average was 5.9 activities per year. This difference (2.9) between these two groups has a *T* value of 3.08 which is significant at more than the 1 percent level of confidence.

Since the difference obtained in this comparison is greater and significant at a higher level of confidence than either number of active compared to Superintendents' Rating or number of passive compared to Superintendents' Rating, there is a basis for assuming that the total number of activities is more related to industrial efficiency than is either of the two factors that make up the total (number of active plus number of passive). This is true because both factors (number of active and number of passive) are also related closely to the criterion; this necessarily causes the difference between the total of number of active and number of passive to be greater and more significant than either of the factors that make up the total.

Total Hours Per Year of Recreational Participation.—The 36 best employees indicated that they spent 33,210 hours during a one-year period participating in recreational activities. This is a mean average of 922.5 hours per employee. The poorest employees indicated on the Activity Invoice that they participated in recreation during 19,892 hours of a twelve-month period. Their mean average, 552.5 hours per year, was 370 hours less than the average of the best employees.

The *T* value of this difference (370 hours) is 3.114 and is significant as well over the 1 percent level of confidence. The relationship between this factor (total hours per year of recreational participation) and the Superintendents' Rating is the greatest of any of the foregoing relationships.

From the results of this part of the study, there are strong indications that there is a high degree of relationship between the

amount of recreation in which an employee participates and the judgment of his superintendent as to the value of the employee to his particular job.

INDUSTRIAL EFFICIENCY COMPARED TO SPECIFIC RECREATIONAL ACTIVITIES

As a part of the total problem, an effort was made to determine whether or not there were certain recreational activities in which the best workers tended to participate more than did the poorest workers. Also, an effort was made to determine whether there were specific recreational activities in which the poorest workers tended to participate more than did the best workers.

In the following activities a significantly larger number of the best employees (as compared with the number of poorest employees) indicated that they participated in the activity at some time during the year: (1) badminton, (2) attending bingo and card parties, (3) clabber (a card game), (4) reading magazines, newspapers, and books, (5) swimming, (6) attending movies.

The following activities were participated in by significantly larger numbers of the poorest group: (1) horseshoes, (2) pingpong, (3) attending circuses and carnivals.

There were quite a number of other activities that might have had a positive statistical significance had the ratios remained the same in a larger sample. Some of these activities were baseball, basketball, billiards, bowling, clubs and hobbies, craftwork, gardening, picnicking, and hunting and fishing.

One should be cautioned against interpreting these results in a fallacious manner. Because many of these activities are either positively or negatively related to Superintendents' Rating does not imply that these activities, if provided for employees, will cause the employees to become more or less efficient. In all probability such would not be the case. There would be no basis for using the results of this phase of the study as criteria for selection of recreational activities that would be included in an industrial recreation program.

AVERAGE AMOUNT OF TIME IN WHICH EMPLOYEES PARTICIPATED PER RECREATIONAL ACTIVITY COMPARED TO INDUSTRIAL EFFICIENCY

The results of this phase of the study would indicate that there is no significant relationship between the average amount of time which employees spend per recreational activity and their efficiency on the job.

The best group participated an average of 102.54 hours per activity. The poorest group's average was 100.4 hours per activity. The difference between these two averages is negligible.

From these data one must conclude that the best and the poorest employees spent approximately the same amount of time (per activity taken part in) for all of the recreational activities.

The results of the study of specific activity average participational time would not warrant the conclusion that either the best or poorest spend more time, per employee who participates, in any of the specific recreational activities. In none of the specific activities was a significant difference found for this phenomenon.

SUMMARY

1. Significance ratios showed total hours of recreation to be more related to Superintendents' Rating than any other factor involved in the study.

2. The other factors which were found to be significantly related to Superintendents' Rating are listed in order of their significance: (1) number of activities, (2) number of passive activities, (3) hours of passive recreational participation, (4) hours of active recreational participation, and (5) number of active recreational activities.

3. Badminton, bingo and card parties, clabber, reading magazines, newspapers, and books, swimming, and movies were the activities in which a significantly larger number of best employees (as compared to poorest employees) tended to participate.**

4. Horseshoes, ping pong, and attending circuses and carnivals were the activities in which significantly more of the poorest employees participated. The difference between the numbers of persons who participated was significant at the 5 percent level of confidence in each of these cases.

5. There was no significant difference between the best group and the poorest group in terms of hours of participation per activity taken part in.

CONCLUSIONS

1. There is a high degree of relationship between recreational participation (as measured by the Activity Invoice) and industrial efficiency (as measured by Superintendents' Rating).

2. There are some specific recreational activities in which a significantly greater number of the better employees (as compared to the poorer employees) tend to participate.

3. There are also some specific recreational activities in which more of the poorer employees (as compared to the better employees) tend to participate.

4. Although both active and passive types of recreation are related to industrial efficiency, there is no significant difference between their degrees of relationship.

5. Although both number of activities and hours of participation are related to industrial efficiency, there is no significant difference between their degrees of relationship.

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* Refer to Table I at end of article.
** Refer to Table II at end of article.

6. Although the poorer employee does not take part in as many activities as does the better worker, he spends as much time per activity in which he participates as does the better employee.

IMPLICATIONS

1. This study implies that the total number of hours spent per year in recreation is a factor which is present among the best workers. This may mean that the best worker is active, dynamic, and effervescent, while the poorer workers may be sedentary, lethargic, and drab.

2. This study does not imply that recreation is either the cause or the result of industrial efficiency. Either might have been the cause, but as such it was outside the scope of this particular study.

3. This study does not imply that the specific activities which had a positive or negative relationship to industrial efficiency were the cause of that degree of relationship. Such may or may not have been true, but this study did not attempt to determine this.

4. This study does not imply that the activities in which significantly larger numbers of the poorer employees took part are not desirable recreational activities for an industrial recreation program. It is quite probable that the activities in question did not cause the inefficiency of the worker but that the inefficient worker only enjoys these activities more than does the better worker.

RECOMMENDATIONS

Upon the basis of this study the following recommendations are made:

1. That research be developed and conducted which would definitely ascertain as to whether recreation—and more specifically, recreation that is provided by industry—is a cause of industrial efficiency.

2. That industry provide recreation for its employees. It *may* be that recreation is a cause of industrial efficiency. *It has been indicated that recreation is a factor in the life of each employee and to a higher degree in the lives of the better employees.*

Industrial recreation can be more efficiently administered, it is more available, and it is cheaper than recreational activities which are paid for and selected by individuals. Because of these factors, coupled with the relationship of industrial efficiency to recreational participation, this study recommends that industry provide recreation for its employees.

3. That the recreation program in industry assume a major role in the industrial relations policy.

TABLE I

Comparison of 36 Good Workers to 36 Poor Workers in Terms of:	*Mean per good employee*	*Mean per poor employee*	*Difference of Percents*	*T Value**	*Level of Confidence*
Total hours per year spent participating in all types of recreation	922.5	552.5	370.	3.114	1%
Hours per year spent participating in "active" recreational activities	399.	235.2	163.8	2.362	2%
Hours per year spent participating in "passive" recreational activities	523.36	317.58	205.78	2.6586	1%
Total *number* of activities taken part in during one year	8.8	5.9	2.9	3.08	1%
Number of "active" recreational activities taken part in during one year	4.9	3.39	1.51	2.18	5%
Number of "passive" recreational activities taken part in during one year	3.9	2.5	1.4	2.868	1%

*Only "T" values of 2.000 or more are accepted as being statistically significant. A "T" value of 2.000 or greater indicates that a difference would occur less than 5% of the time as a result of chance alone.

TABLE II

COMPARISON OF 36 GOOD WORKERS TO 36 POOR WORKERS IN TERMS OF SPECIFIC ACTIVITIES IN WHICH THEY PARTICIPATED

Activity	Number of Good	Number of Poor	% of Good	% of Poor	S. D. of Good %	S. D. of Poor %	Difference of Per Cents	S. D. of Difference	T Value
Baseball	11	7	30.5	19.4	*	*	11.1	*	*
Badminton	5	0	13.8	0	.058	.016	13.8	6.00	2.300
Basketball	7	3	19.4	8.3	*	*	11.1	*	*
Banquets	8	6	22.2	16.6	*	*	5.6	*	*
Bicycling	2	1	5.5	2.7	*	*	2.8	*	*
Billiards	8	3	22.2	8.3	*	*	13.9	*	*
Bingo and Cards	14	5	38.8	13.8	.082	.058	25.	10.	2.500
Boating	7	5	19.4	13.8	*	*	5.6	*	*
Bowling	12	6	33.3	16.6	*	*	16.7	*	*
Camping	4	4	11.1	11.1	*	*	0	*	*
Boxing	1	0	2.7	0	*	*	2.7	*	*
Checkers	1	3	2.7	8.3	*	*	—5.6	*	*
Clabber	15	7	41.6	19.4	.084	.068	22.2	10.8	2.055
Clubs and Hobbies	10	5	27.7	13.8	*	*	13.9	*	*
Cribbage and Dominoes	1	0	2.7	0	*	*	2.7	*	*
Craftwork	8	3	22.2	8.3	*	*	13.9	*	*
Dancing	11	8	30.5	22.2	*	*	8.3	*	*
Flying	1	0	2.7	0	*	*	2.7	*	*
Gardening	16	11	44.4	30.5	*	*	13.9	*	*
Handball	2	1	5.5	2.7	*	*	2.8	*	*
Hiking	1	1	2.7	2.7	*	*	0	*	*
Horseshoes	0	4	0	11.1	.016	.054	—11.1	5.5	2.002

*Only T values of 2.000 or more are accepted as being statistically significant.

TABLE II—*Continued*

COMPARISON OF 36 GOOD WORKERS TO 36 POOR WORKERS IN TERMS OF SPECIFIC ACTIVITIES IN WHICH THEY PARTICIPATED

Activity	Number of Good	Number of Poor	% of Good	% of Poor	S. D. of Good %	S. D. of Poor %	Difference of Percents	S. D. of Difference	T Value
Picnicking	13	8	36.1	22.2	*	*	13.9	*	*
Ping Pong	1	6	2.7	16.6	.026	.061	—13.9	6.6	2.106
Rifle and Pistol	9	10	25.	27.7	*	*	—2.7	*	*
Reading Magazines, Newspapers and Books	23	14	63.8	38.8	.080	.081	25.	11.4	2.192
Sightseeing and Pleasure Driving	17	13	47.2	36.1	*	*	11.1	*	*
Social Parties	3	3	8.3	8.3	*	*	0	*	*
Softball	4	6	11.1	16.6	*	*	—5.5	*	*
Swimming	17	7	47.2	19.4	.081	.068	27.8	10.6	2.396
Washers	1	3	2.7	8.3	*	*	—5.6	*	*
Attending Lectures and Concerts	2	0	5.5	0	*	*	5.5	*	*
Attending Sporting Events	10	6	27.7	16.6	*	*	11.1	*	*
Attending Circuses and Carnivals	4	13	11.1	36.1	.052	.080	—25.	9.5	2.631
Hunting and Fishing	25	18	69.4	50.	.082	.0785	19.4	11.3	*
Movies	30	21	83.3	58.3	.062	.081	25.	10.2	2.451

Report of a Study on Administration and Finance of High School Athletics for Boys

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PROBLEMS concerning the administration and finance of athletics for high school boys persist in most public school systems. It is true that in many cities policies governing high school athletics are fairly well established, but, questions continue to arise which challenge and perplex those in charge of athletic programs.

In Springfield, Massachusetts, during the summer of 1945, a study was made relating to the athletic problems which concern the high school principals, teachers, and supervisors of health and physical education in that city. The study was conducted as follows:

1. A check list was distributed to 108 city supervisors of physical education, state directors of physical education, and physical education authorities in universities.
2. There were responses from 51 cities in 25 states, also from eight state directors, and four other experts in the field.
3. A summary was made of the findings.
4. Conclusions were drawn from the summary. These conclusions are a part of the summary in this report.
5. Recommendations were made which would affect the local situation.

SUMMARY AND CONCLUSIONS

1 How many high schools are there in your city? Enrollment? The number ranged from 1 to 42. The enrollment ranged from 320 to 48,551.

2. Are the athletic teams coached by members of the health and physical education staff? Yes—44; No—2; Some—3. By other faculty members? Yes—23; No—15; Some—5. If so, is there extra compensation? 24 report extra compensation for this work; 14 do not. How much?

The compensation rate ranges from $3 per day to $750 per season. Are there special coaches? Yes—none; No—28, Some—3.

The trend is definitely toward coaching by teachers of the health and physical education staff. In many cases, however, there are not a sufficient number of teachers of health and physical education to cover the entire program, and other faculty members are called upon

to supplement them. The number of cities offering extra compensation to those who coach seems to balance with the number of cities where this work is considered a part of a regular teaching assignment. There is no one particular section of the country where either policy is dominant.

3. Which sports are included in the interscholastic athletic program?

Basketball	50	Indoor Track	13
Football	50	Wrestling	11
Outdoor Track	48	Soccer	10
Baseball	46	Ice Hockey	7
Golf	31	Fencing	3
Tennis	31	Volleyball	3
Cross Country	23	Bowling	2
Swiming	22	Boxing	2

There is a strong trend toward widening the scope of the athletic program. Sixteen different sports were listed in the responses to the check sheet. It is interesting to note an increasing interest in track, tennis, golf, cross country, and swimming.

4. Is the program financed by the Board of Education? Yes—14; No—22; Some—12. In the case where the answer to this question is "some" the part financed by the Board of Education is usually the salary item for coaches.

What is the cost? Where the cost is met by the Board of Education among the cities responding, the range is from $2,000 to $100,082. The cities expending $2,000 Board of Education money are cities with 1, 2, and 4 high schools, whereas the city expending $100,082 has 15 high schools. This would lead to the assumption that there is no unity in this item.

How is the amount of the budget determined? This question was answered by comparatively few cities. The majority of those answering report that the amount of the budget is determined by the School Committee usually upon the recommendation of the director or supervisor of physical education.

Is the budget broken down in terms of specific sports? Yes—9; No—15; Some—1.

If the Board of Education supplies funds, are students admitted to games by student association tickets? Yes—15; No—5; Some—5. In the cases where the response is "some" the answer usually indicates free admission with a student association ticket, or reduced admission fees.

How are other activities financed, such as glee club, dramatic club, etc.? There was great difference among the answers to this question. One answer, for example, states that the Board of Education finances all mentioned activities. Several answers stated that football gate receipts covered the cost of many other activities. A fairly large number, however, reported that the sale of student

association or general association tickets financed these activities as well as athletics.

Is the program financed by a general student organization in individual schools? Yes—15; No—3; Some—1. There is a strong trend toward the financing of high school athletics by general student associations.

Is the program financed by a student athletic association in individual schools? Yes—8; No—3; Some—2. The financing of athletics by student athletic associations is a fairly common practice but not so common as that described directly above.

Is there an admission charge to games? Yes—36; No—1; Some—7. Admission ranged from ten cents to $1.50.

Are athletic uniforms or any part of them provided for participating students? Yes—46; No—3; Partly—3; for football only—1; shoes only—5. There is a strong trend toward providing complete athletic uniforms for students participating in this program.

5. Is there a Board of Control? Yes—43; No—7.

6. How are accounts audited? Each school—2; Bank Teller—1; C.P.A.—7; School Business Dept.—35; Faculty Committee—2. The auditing of accounts by school business departments is the most common practice.

7. Please comment on the idea of all high schools within a city pooling gate receipts either totally or in part with redistribution to schools according to enrollment. Has such a plan ever been tried in your city? Yes—9; one for more than 20 years, one for 15 years. No—36; one tried it for one year, "unsuccessfully"; partly—4. There is an apparent feeling among those in charge of high school athletics that it might be desirable to pool the gate receipts of all schools within the city. Few cities have tried this plan, however.

8. Is there an athletic insurance benefit plan in your city? Yes—26; one stated, "not officially," but recommended that students finance it. No—22.

The principle of "individual differences" seems to be firmly established in the administration and finance of high school athletics for boys. Each city has its own scheme of organization, designed to meet the needs of the local situation. The only strong agreement is that coaching of athletics should, wherever it is possible, be in the hands of teachers of health and physical education.

PRESENT PRACTICES IN SPRINGFIELD

Interscholastic athletics in Springfield, Massachusetts, are controlled by a board consisting of the senior high school principals and the supervisor of health, physical education, and safety. Recommendations are made by the coaches to this board whenever changes in policy seem desirable.

The program is financed by the General Student Association in

each school, with the exception of the coaches' salaries. This association sells a student ticket which enables a pupil to attend dances, receive the school paper, attend home games, etc. Receipts from games do not go directly to the financing of the athletic program, but to the student associations. The greater the income from games, of course, the greater the budget of all organizations within the school.

The entire cost of equipment, transportation, officials' fees, and police protection comes from the association.

The specific amount allocated to each organization is determined by the members of the student association committee, on which there is a member for the Department of Health, Physical Education, and Safety.

The only athletic contests for which admissions are charged are football and basketball. The admission to football games is 75c except for one game which is $1.00. The basketball admission is 50c.

Coaching is done by teachers of the health, physical education, and safety staff and every attempt is made to equalize the coaches' programs in physical eduaction to compensate for their coaching duties. In the few instances where it is necessary to engage faculty members as coaches, extra compensation is granted, ranging from $100 - $200 per season. Coaches engaged who are not members of the public school system must have the approval of the superintendent of schools.

At the present time the following sports are included in the Springfield High School athletic program: soccer, football, basketball, bowling, baseball, track, tennis, and golf. As soon as the Eastern States Coliseum is again available, it is expected that hockey will be resumed.

PROPOSED RECOMMENDATIONS FOR THE LOCAL SITUATION IN SPRINGFIELD

It is recommended that the program of high school athletics be expanded to include all sports suitable for boys of high school age. This expansion would necessitate additional coaching staff. Wherever possible, coaches should be members of the health and physical education staff, and coaching should be a part of the regular teaching assignment. Those teachers of health and physical education who carry a coaching assignment should be given a lighter class load than those teachers who have no after-school responsibilities.

As men teachers are added to the faculty of any department, whenever possible, men with coaching ability and experience should be appointed ,and coaching should be considered a part of the regular teaching assignment.

No change should be made in the present plan of financing athletics, but with the expansion of the sports program should come an equal recognition of sports, and each school should allocate funds for the conduct of all sports included in the program.

A Study of Some Relationships Between Performance Tests and Certain Physiological Measures Associated with Maximal and Submaximal Work

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THE assessment of exercise tolerance may be attempted directly, through measurement of an individual's performance, or indirectly, through measurement of the physiological correlates of physical activity. A study of the interrrelationships between various measures of performance and physiological adjustments to exercise should be of value in furthering the understanding of exercise tolerance and its assessment. In the present investigation, interrelations were studied between (1) performance in runs of 50 and 200 yards and in maximal number of steps on a 12" stool, (2) a test based upon performance in stool stepping and the response of the heart rate to it, and (3) certain physiological measures during and following a standard submaximal exercise of 8 minutes' duration and following a maximal exercise during which the subject worked presumably to exhaustion.

SUBJECTS

The subjects used were college women majoring in physical education ranging in age from 18 to 21 and women teachers of physical education ranging in age from 23 to 45. All were qualified by medical examination for unlimited activity. The activity history and current participation in vigorous physical activity varied, but may be fairly described as representative of such groups and more extensive than that of the general college and adult population. None was or ever had been trained to an extremely high degree of performance in specific speed or endurance events. Some of the performance tests were given as part of class work while all of the physiological studies were made on volunteer subjects. Every effort was made to have the subjects understand the nature and purpose of the work and to elicit their unreserved cooperation in exerting

themselves to the limits of their capacity. The response of the subjects may be fairly described as highly satisfactory, although certain limitations will be discussed later.

PERFORMANCE MEASURES

Runs.—Runs of 50 yards and 200 yards were timed. In an effort to eliminate the effect of variations in the mechanics of the start and to provide for attainment of maximal speed throughout, the actual distances run at top speed were 60 yards in the one case and 210 in the other, time being recorded at the 5-, 55-, and 205-yard points. There was a time interval of from 15 to 20 minutes between the two runs. Some of the runs were made on a cinder track approximately 250 yards in length, and some on a turf field approximately 125 yards in length, the latter necessitating a turn around a post at the halfway distance. Time made on the turf field was converted to track time by means of a regression equation based on a correlation of .79 between times made on the two fields by 20 subjects. Shoes worn were rubber-soled and uncleated. The runners ran in pairs, and were timed by one or more experienced timers using stop watches calibrated to 1/5 second and recently synchronized. A reliability coefficient of .90 was found between successive trials of the 200-yard run. The interval between trials was approximately one week, the number of subjects 15.

The runs were scored in five ways. For one, the time on the 200-yard run was used. For the others, the concept of work decrement as an index of an individual's endurance, used by numerous investigators [5, 7, 13, 15, 17]* was employed. The ratio $\frac{\text{Time on 200-yd.}}{4(\text{Time on 50-yd.})}$ called hereafter the Run Ratio, and the drop-off calculated as 4(Time on 50) Minus Time on 200, called hereafter the Run Drop-off, were computed as well as a score from the table presented in the U. S. Office of Education *Handbook*,[6] and a score developed from the data of present study.

The *Handbook* method of scoring based on the running scores of 700 college women was devised on the basis of score and of subjective estimate of the runner's capacity.

> The average difference in the 200 yard score, over four times the 50-yard score for groups who had uniform scores for 50-yards, indicated a definite trend, which, combined with subjective ranking in endurance, was used to develop the scoring table.**

This scoring permits a greater decrement in the time of the long

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* Superior figures refer to bibliography at end of article.

** U. S. Office of Education, *Handbook of Physical Fitness for Students in Colleges and Universities*, page 86.

run when the corresponding short run is performed at greater speed. Some such adjustment seems imperative both from a theoretical consideration of the relationship between a given maximal capacity and the relative portion of the maximal used in activity of varying speed,[16] and from practical experience. There are apparent limitations in this method of scoring. Correction for variations in time made by different groups under varying external conditions (surface, shoes, etc.) is not possible due to the empirical nature of the scoring. For example, means for the 50-yard run obtained at three separate institutions were 7.71 sec., 7.04 sec. and 8.4 sec. with corresponding means for the 200-yard run of 35.36 sec., 31.54 sec. and 35.9 sec. A number of the subjects in the present study, performed the runs with greater speed and less decrement than provided for in this method of scoring, whereas another group showed less speed and greater decrement.

For the present study a new method of scoring the runs based on standard scores was devised. This will be called the C index. "C" scales[8] with eleven intervals of .5 sigma each were constructed from the 50-yard and from the Run- Ratio data. A scale score of 5 corresponds to performance scores between .25 sigma above and .25 sigma below the mean; a scale score of 10 corresponds to performance scores of 2.75 sigma or more above the mean; a scale score of zero, to performance scores of 2.75 sigma or more below the mean.

A table of C Index scores (Table I) was constructed whereby for mean speed on the 50-yard run, i.e., a score of 5, a C Index score of 5 was assigned to a corresponding Run-Ratio score of 5, the Index score increasing or decreasing by one interval for each corresponding variation in the Run-Ratio score. For an equivalent C Index score, each increase of .5 sigma in time on the short run necessitated a decrease of .5 sigma in the Run-Ratio, and each decrease of .5 sigma in time on the short run permitted an increase of .5 sigma in the Run-Ratio. The nature of the data does not warrant narrower scale divisions. This adaptation for speed is admittedly arbitrary. The basic concept, however, seems reasonable and the scoring can be adapted to other sets of data having different raw scores and variability.

The total number of subjects performing the running tests was 49, of whom 17 did the maximal and standard submaximal exercises.

Maximal Steps.—The subject mounted and dismounted a platform using 4 counts for each cycle. The platform was 12" in height, equipped with a hand rail 4 feet in height, and with an electrical contact connected to a recording pen. On the graphic record obtained

TABLE I

"C" INDEX SCORES

Time on 50-yard run*	Ratio: Time on 200-yard run* / Time on 50-yard run										
	10	9	8	7	6	5	4	3	2	1	0
10						0	1	2	3	4	5
9					0	1	2	3	4	5	6
8				0	1	2	3	4	5	6	7
7			0	1	2	3	4	5	6	7	8
6		0	1	2	3	4	5	6	7	8	9
5	0	1	2	3	4	5	6	7	8	9	10
4	1	2	3	4	5	6	7	8	9	10	
3	2	3	4	5	6	7	8	9	10		
2	3	4	5	6	7	8	9	10			
1	4	5	6	7	8	9	10				
0	5	6	7	8	9	10					

*Each scale score is equivalent to .5 sigma. A scale score of 5 includes performance scores between .25 sigma below and .25 sigma above the mean; a scale score of 10 includes performance scores 2.75 sigma or more above the mean; a scale score of 10 includes performance scores 2.75 sigma or more below the mean. The approximate index score is read from the table (see text).

time in seconds was also registered. A metronome, set at 200 beats per minute, was used to mark the pace. The subject was urged to use both arms and legs in the exercise. Full extension of the hip joint at the top of the step was required. After indoctrination and a preliminary exercise period varying in duration according to the individual's subjective reaction, the subject began the exercise and continued until she stopped, presumably from exhaustion, or until she was stopped by the operator when she could no longer maintain the pace set in acceptable form. From the graphic record both the duration of the exercise and the number of steps were counted. Inability to follow the metronome beat precisely was evidenced in some cases. A variation of $\pm$ 2 steps was accepted and no correction was made for it. Two tests on separate days were made for all subjects. At the beginning of the study the statement of Powell and Howe[17] based on evidence which "would tend to indicate that one's capacity to exert herself to the utmost for a brief period of time is a rather stable thing and that the respiratory and circulatory mechisms are quite consistent in meeting this sudden demand"* was ac-

* Powell and Howe, *Physical Fitness and Endurance*, page 20.

cepted. It was intended that the first test be used as a practice only. No graphic record of this test was made. Time only was taken, and no physiological measures were recorded. When it became evident that reliance in the statement quoted was not justified, and that the rate of stepping was subject to variation, graphic records for all tests were made. The higher score recorded has been used in all computations. Duplicate measures were available for 17 subjects. The correlation between them was .70. The total number of subjects was 24.

Brouha Step-Test.—The Brouha-Clarke Step Test,[1, 2] in which the score is based (1) on the duration of the subject's performance on a stool-stepping exercise, and (2) the heart rate following such exercise, was given to 75 subjects, of whom 21 also did the maximal and submaximal exercises.

PHYSIOLOGICAL MEASURES

Measurement of certain physiological responses during and following a standard, submaximal exercise and the maximal exercise described above were made. The primary purpose was to obtain a measure of maximal O_2 supply. The submaximal exercise was designed to approximate "crest load," the maximal work possible for a subject maintaining a steady state of O_2 consumption.[10] The severity of the exercise is indicated by the approximately tenfold increase in rate of O_2 consumption over the resting level.[4] The maximal exercise was designed to cause the subject to incur the maximal O_2 debt tolerable. The development of an index of maximal O_2 supply based on data from these exercises will be described later. A description of the standard exercise and experimental procedures will be made first, followed by an outline of the physiological responses observed.

Submaximal Exercise.—The subject reported to the laboratory at about 8 A.M. in a post-absorptive condition. She was first equipped with electrodes connected to a cardiochronoscope,[11] whereby a continuous graphic record of the heart rate, throughout the exercise and recovery periods, was obtained. Following a rest period of 15-20 minutes, or until the heart reached a steady minimal rate, she was equipped with a face mask connected to an open spirometer system. She then sat for approximately 20 minutes while two resting metabolism determinations were made, then performed a stool-stepping exercise on the platform described above at the rate of 30 steps per minute for 8 minutes. She then sat during a recovery period until the rate of pulmonary ventilation had returned to the pre-

exercise level. If the heart rate had also reached the pre-exercise level the experiment was terminated; if not, the mask was removed and the post-exercise period was extended five minutes.

The metabolism apparatus used is a later model of that developed by Shock, *et al*[22] and is essentially an elaboration of a Douglas bag. It consists of two 60-liter Tissot spirometers equipped with appropriate valves, sampling outlets, timing and recording devices so that a continuous graphic record is obtained for respiratory rate and pulmonary ventilation, and air samples can be withwrawn for analysis at frequent intervals, thus affording data for calculation of O_2 consumption. The maximal capacity of the system is approximately 70 liters per minute. Four to six samples of expired air, the number depending on the rate of ventilation, were withdrawn, during the last 5 minutes of the exercise, into glass sampling tubes and stored over Hg under pressure until analyzed in a Haldane analyzer. Samples were analyzed also from each spirometer of air expired during the recovery period. Duplicate determinations of resting metabolism were made to improve the reliability of the base line from which the excess O_2 used during exercise and post-exercise periods was computed, and to furnish an index of the accuracy of all the technical procedures. Agreement between duplicate determinations was in general within 5 percent. Gas samples were analyzed in duplicate or in triplicate if necessary to obtain agreement within .05 percent. The majority of duplicate analyses agreed within .03 percent.

From the data of the submaximal exercise, the following physiological measures were calculated:

1. A ratio, $\frac{\text{Excess } O_2 \text{ used during exercise}}{\text{Total excess } O_2 \text{ consumption}}$, to be known hereafter as the Submaximal O_2 Ratio. It is argued that the greater the proportion of O_2 used during exercise and the smaller the O_2 debt associated with a given exercise, the greater the capacity of the individual for physical work.

2. The maximal O_2 intake in cc/kg/m during the last 5 minutes of the exercise.

3. Relative efficiency, the reciprocal of the total excess O_2 per kg used during exercise and recovery. Since the number of steps taken was the same for all, the effective work done by each subject was directly proportional to body weight.

4. Heart rate in beats per minute.

5. Pulmonary ventilation in liters per minute per kg, corrected to 37°C.

6. Ventilation Index, $\frac{\text{Pulmonary Ventilation/m}}{\text{Vital Capacity}}$, regarded by Harrison[9] as an objective measure of dyspnea and used in the study of cardiac function in patients with cardiac involvement. According to Harrison,

> A person becomes short of breath when his actual volume becomes more than a certain fraction of his maximal possible volume and the closer the actual ventilation approaches the maximal possible ventilation, the severer the dyspnea becomes. This principle, which was first suggested by Peabody, is a simple one and is of fundamental importance in the understanding of cardiac and most other types of dyspnea.*

In the present study no correction was made for deviation from normal weight.

7. Ventilation Equivalent, volume of the pulmonary ventilation associated with consumption of 100 cc O_2 and suggested as a possible index of the efficiency of the ventilation.[21]

8. O_2 pulse, cc of O_2 utilization per heart beat.[10]

Measures 4 - 8 were calculated for rest, average of exercise, maximal of exercise, absolute and relative rise of average and maximal during exercise in relation to the resting value. For the heart rate, the ratio $\frac{\text{2 post exercise}}{\text{1 pre-exercise}}$ called hereafter the Heart Ratio was also calculated. This measure corresponds to the simplified pulse-ratio of Tuttle and Dickinson.[24]

The total number of subjects doing the submaximal exercise was 24. Seven of the subjects performed the exercise on two different days, approximately one week apart. Results from these duplicate determinations were analyzed to secure some idea of the reliability. Self-correlations, determined by the Spearman Rank-Difference Method, were as follows: submaximal O_2 ratio, .75; relative efficiency, .93; maximal O_2 intake, .96; excess O_2 used during exercise, .82; and O_2 debt, .75.

Maximal Exercise.—For the second trial of the "maximal steps" exercise described above, the subject reported to the laboratory at about 8 A.M. in a post-absorptive state. The exercise was preceded by a rest period until heart rate reached a steady minimal, followed by a period of about 20 minutes during which two determinations of resting metabolism were made. Immediately upon cessation of the exercise, the subject was attached to the face mask and metabolism apparatus. During the recovery period, terminated as in the submaximal exercise, she stood, sat, or reclined according to her own feelings of comfort. All changes of position were made smoothly and gradually. The number of maximal steps performed at the time of O_2 determination was not necessarily the greater of the two trials.

* Harrison, *Failure of the Circulation*, page 193.

From the data of the maximal exercise, the following measures were calculated.

1. Total O_2 debt in cc/kg.
2. Heart rate, in beats per minute during rest, maximal during exercise, absolute and relative value of maximal during exercise in relation to resting value, ratio $\frac{2 \text{ post exercise.}}{1 \text{ pre-exercise.}}$
3. Pulmonary ventilation, liters/kg, for first 5 minutes of post-exercise period.
4. Ventilation Index for the first 5 minutes' post-exercise.

Combined O_2 Supply.—From the O_2 consumption data of the two exercises, maximal and standard submaximal, a measure indicative of total O_2 capacity was calculated. It is postulated that total O_2 capacity is determined by maximal capacity for transport plus maximal O_2 debt tolerated. For a theoretical consideration of this concept, reference may be made to Schneider.[20] Technical limitations precluded the determination of O_2 transport from analyses of blood samples. The Submaximal O_2 Ratio, described above, is assumed to be an index of maximal transport. Sigma scores were calculated for the Submaximal O_2 Ratio and for the maximal O_2 debt and added to give a measure, called in this study, combined O_2 supply. Of all physiological measures, the combined O_2 supply is regarded by us as having the greatest theoretical validity as a criterion of an individual's exercise tolerance.

RESULTS AND DISCUSSION

Of the varying number taking the separate tests, 13 individuals took all of the tests. An effort was made to determine the extent to which the small group was representative of the total number studied in each test. For most of the measures, the *T* ratio for differences was calculated for the group of 13 in relation to the largest group available, 24 for the maximal steps and physiological measures, 75 for the Brouha test, 49 for the running tests. The ratios ranged from .02 to 1.18, in no case approaching significance. For a number of the measures including those with the largest *T* ratio of difference, cumulative distributions were made and plotted on probability graphs. From these some estimate could be made of the normality of the samples. The only markedly skewed distributions apparent were in the U.S. Office of Education *Handbook* scores which were high. Inspection of these graphs also showed only slight differences between the two groups. This use of probability graphs has been developed by Henry.[12]* The size of the groups precluded more precise demonstration of the adequacy of sampling.

Relationships between the various items were studied by means of the Pearson product-moment coefficient of correlation, the level

* Samples showing the method are available upon request.

of significance of the correlation judged by Fisher's T.[8] Zero-order correlation coefficients were computed between each of the performance measures and the physiological measures for the largest group available and for the group of 13 who did all of the tests; of these only the latter will be reported here. In the accompanying tables of intercorrelations, the size of the coefficient indicative of significance at the 1 percent and at the 5 percent level of confidence is noted. Significance at the 1 percent level means that, with further samples of the size used, in only one case out of 100 would there be no relationship between the variables; at the 5 percent level, that in only 5 cases out of 100 would there be no relationship.

TABLE II

INTERCORRELATIONS BETWEEN RUNNING SCORES*

N = 49

A coefficient of .354 is significant at the 1% level of confidence
A coefficient of .273 is significant at the 5% level of confidence

	Time 200-yd.	Run Ratio	Run Drop-off	U. S. Handbook	C Index
1. Time 50-yd.	.87	—.02	.17	—.51	—.73
2. Time 200-yd.		.47	.61	—.86	—.85
3. Run Ratio			.97	—.79	—.61
4. Run Drop-off				—.86	—.74
5. U. S. Handbook					.90
6. "C" Index					

*It should be noted that in measures 1 to 4, a high score is indicative of poor performance, and in measures 5 and 6, a high score is indicative of good performance.

From Table II, intercorrelations between running scores, it may be seen that the time on the 200-yard run has a higher relationship with the time on the short run than do any of the other methods of scoring; scoring by the Drop-off or Run-Ratio method, between which there is negligible difference, reflects the initial speed on the 50-yard run less than by either the *Handbook* or C index method which are closely related. The same relationships are indicated in the small group of 13 (Table V). In the development of a measure of work capacity of an endurance nature, minimizing the importance of the effect of speed is desirable. Both theoretical consideration and practical experience, however, force recognition of

a relationship between speed and endurance in physical ability. This point will be discussed later. The correlations between the Drop-off and Ratio scoring on the one hand and the *Handbook* and C Index scoring on the other indicate that to a large extent the same thing is being scored by all four methods.

TABLE III

CORRELATIONS BETWEEN COMBINED O_2 SUPPLY AND OTHER PHYSIOLOGICAL MEASURES

N = 24

A coefficient of .515 is significant at the 1% level of confidence
A coefficient of .404 is significant at the 5% level of confidence

a) O_2 MEASURES, WEIGHT

Submaximal O_2 Ratio $\frac{\text{(Excess } O_2 \text{ of exercise)}}{\text{(Excess } O_2 \text{ exercise and recovery)}}$	.76
Maximal O_2 debt (Excess O_2/kg, recovery from maximal exercise)	.81
Maximal O_2 intake (cc/kg/m utilized during submaximal exercise)	.19
Relative efficiency $\frac{(1)}{\text{(Excess } O_2\text{/kg, submaximal exercise)}}$	.49
Weight	—.29

b) RESPONSES ASSOCIATED WITH SUBMAXIMAL EXERCISE

	Heart Rate	*O_2 Pulse*	*Pulmonary Ventilation*	*Ventilation Index*	*Ventilation Equivalent*
Rest	.05	.12	.31	—.23	.11
Average Exercise	—.24	—.11	—.32	—.57	—.37
Maximal* Exercise	—.30	—.15	—.32	—.55	—.48
Ave. Exercise — Rest	—.31	—.06	—.34	—.59	.56
Max.* Exercise — Rest	—.39	—.08	—.43	—.61	.65
Average Exercise / Rest	—.19	.05	—.54	—.54	—.53
Maximal* Exercise / Rest	—.09	.00	—.57	—.57	—.68
Ratio: 2′ Post. Ex. / 1′ Pre. Ex.	—.38				

*For ventilation equivalent, minimal should be substituted for maximal.

c) RESPONSES ASSOCIATED WITH MAXIMAL EXERCISE

Maximal Heart Rate during exercise	.18
Maximal Heart Rate — Resting Heart Rate	.17
Maximal Heart Rate / Resting Heart Rate	—.11
Ratio: Heart Rate 2′ post-exercise / Heart Rate 1′ pre-exercise	—.03
Pulmonary Ventilation/kg, 5′ post exercise	.40
Ventilation Index 5′ post exercise	.13
Pulmonary Ventilation/kg, 5′ post-exercise / Pulmonary Ventilation/kg, 5′ pre-exercise	.37

In Table III the relationships found between the combined O_2 supply, regarded by us as having the highest theoretical validity as

a measure of exercise tolerance of any of the measures studied, and other physiological measures are shown. From Table IIIa an estimate may be made of the relative importance of the two components, the Submaximal O_2 Ratio and the maximal O_2 debt. The relationship with relative efficiency gives an indication of the effect of skill in the performance of the submaximal exercise.[5] The level of maximal O_2 utilization and weight are, in these data, only slightly related to the combined O_2 supply measure.

In Table IIIb there are shown the relationships between the primary criterion, combined O_2 supply, and other physiological measures computed for the preliminary rest period, the submaximal exercise period, and the absolute and relative changes associated with the exercise. It is clear that in this study, the measures concerned with cardiac function (heart rate and O^2 pulse, are not closely related to the criterion, while those concerned with ventilation during exercise do in general show a fairly high degree of relationship. Change from the resting level during adaptation to exercise is in general more significant than the absolute level reached. It may be noticed that the Ventilation Index is more significant than pulmonary ventilation alone. The correlations of the relative change during exercise are of course the same for the two.

From Table IIIc, it is evident that in this study the measures associated with maximal exercise are of little or no significance. This is in marked contrast to results reported by Taylor.[23] Whether this exercise was truly maximal for each subject is questionable. It can be said that the exercise did not require special skill, that the subjects had had practice in the technique of the test, that an effort was made to have part of the work done by the arms in order to minimize localized fatigue in the legs, and that we have every reason to believe that each subject exerted effort which was both thought and felt by her to be maximal. The purpose of the exercise as given was to cause the subject to build up a maximal O_2 debt. Since the few who were stopped by the operator were working at a decreased rate of speed it was assumed that the O_2 debt had reached a maximal value and that the energy cost of the activity was being met from current rather than reserve supply of O_2. The point of exhaustion for such subjects as were used will be considered later under general discussion.

In Table IV are presented correlations between some per-

TABLE IV

CORRELATIONS BETWEEN PERFORMANCE MEASURES AND SOME PHYSIOLOGICAL MEASURES ASSOCIATED WITH SUBMAXIMAL WORK
N = 13
A coefficient of .684 is significant at the 1% level of confidence
A coefficient of .553 is significant at the 5% level of confidence

	Maximal Steps	*Brouha Step Test*	*Time 50-yd.*	*Time 200-yd.*	*Run Ratio*	*Run Drop-off*	*U.S. Hand Book*	*C Index*
Heart Rate								
Rest	—.06	—.10	—.45	—.31	—.07	—.13	.23	.30
Ave. Exercise	—.19	—.25	—.03	.08	.21	.23	—.27	—.20
Max. Exercise	—.21	—.32	.08	.13	.22	.27	—.33	—.28
Ave. Ex. — Rest	—.15	—.18	.29	.32	.26	.35	—.45	—.40
Max. Ex. — Rest	—.15	—.21	.31	.30	.25	.33	—.46	—.40
Ave. Exercise / Rest	—.14	—.09	.40	.43	.24	.30	—.51	—.38
Max. Exercise / Rest	—.14	—.01	.47	.41	.18	.29	—.44	—.41
Ratio	—.26	—.30	.26	.34	.37	.38	—.41	—.33
Pulmonary Ventilation cc/per kg								
Rest	.39	.42	—.63	—.52	—.36	—.24	.56	.52
Ave. Exercise	—.36	.18	.12	.21	.29	.26	.18	—.24
Max. Exercise	—.46	—.05	.19	.32	.41	.37	—.30	—.35
Ave. Ex. — Rest	—.46	.15	.24	.43	.41	.39	—.31	—.39
Max. Ex. — Rest	—.57	—.00	.34	.43	.45	.48	—.42	—.51
Ave. Exercise / Rest	—.70	—.32	.83	.79	.43	.53	—.75	—.74
Max. Exercise / Rest	—.75	—.39	.80	.80	.46	.56	—.80	—.77
Ventilation Index								
Rest	.28	—.09	—.54	—.41	.05	—.05	.45	.37
Ave. Exercise	—.59	—.49	.39	.51	.50	.48	—.48	—.47
Max. Exercise	—.69	—.71	.44	.67	.49	.54	—.67	—.57
Ave. Ex. — Rest	—.64	—.49	.48	.58	.49	.50	—.55	—.54
Max. Ex. — Rest	—.69	—.54	.47	.63	.52	.54	—.60	—.59
Ave. Exercise / Rest	—.70	—.32	.83	.79	.43	.53	—.75	—.74
Max. Exercise / Rest	—.75	—.39	.80	.80	.46	.56	—.80	—.77
Ventilation Equivalent								
Rest	.13	.33	—.15	—.01	.31	.17	.15	.04
Ave. Exercise	—.51	—.24	.15	.41	.55	.41	—.31	—.32
Min. Exercise	—.51	—.25	.43	.50	.58	.56	—.41	—.52
Ave. Ex. — Rest	.77	.49	—.48	—.48	—.21	—.24	.56	.47
Min. Ex. — Rest	.71	.48	—.56	—.55	—.21	—.30	.75	.54
Ave. Exercise / Rest	—.82	—.49	.51	.59	.36	.39	—.61	—.60
Min. Exercise / Rest	—.81	—.49	.70	.68	.40	.51	—.72	—.69

formance measures and physiological measures of the small group of 13 subjects who took all of the tests. Similar correlations were also computed for each performance test using the largest number of cases available in each, 24 for the maximal steps test, 21 for the Brouha Test, and 17 for the running scores. In the two sets of data the correlations are not identical but are of the same sign and in most cases of the same relative magnitude. Correlations between O_2 pulse of submaximal exercise and all physiological measures associated with maximal work on the one hand and performance measures on the other are not reported here, since with a single exception (post-exercise pulmonary ventilation of maximal exercise and the *Handbook* score), none was large enough to be of significance at the 5 percent level of confidence, in either the larger or the smaller samples. Correlations between heart rate and performance measures are included, even though low, since this measure has been used so extensively in functional tests.

The trend toward significant relationship is most evidenced between Ventilation Index and Ventilation Equivalent on the one hand and the performance scores on maximal steps, time on 200-yard run, and the *Handbook* on the other. The relative change in pulmonary ventilation, which is equivalent to the relative change in Ventilation Index, also shows a high degree of relationship with these same performance measures.

TABLE V

INTERCORRELATIONS BETWEEN PERFORMANCE SCORES, O_2 SUPPLY

N = 13

Coefficient of .684 significant at the 1% level of confidence
Coefficient of .553 significant at the 5% level of confidence

	Max. Steps	*Brouha Test*	*Time 50-yd.*	*Time 200-yd.*	*Run Ratio*	*Run Drop-off*	*U.S. Handbook*	*C Index*
Combined O_2	.74	.64	—.60	—.69	—.46	—.53	.77	.65
Submaximal O_2 Ratio	.42	.42	—.55	—.47	—.29	—.45	.58	.47
Maximal O_2 Debt	.49	.49	—.42	—.73	—.39	—.43	.64	.54
Maximal Steps		.60	—.58	—.80	—.70	—.73	.78	.81
Brouha Test			—.30	—.48	—.51	—.50	.51	.46
Time 50				.94	.45	.58	—.87	—.89
Time 200					.73	.80	—.97	—.93
Run Ratio						.98	—.70	—.80
Run Drop-off							—.81	—.90
U. S. Handbook								.96

In Table V, the correlations of the various performance measures with each other, and with the measures of combined O_2 supply are shown.

Consideration of relationships between the speed on the initial 50-yard run and the other measures is of interest. The correlations of the time of the 50 with the time on the 200 and with the two

arbitrary scores developed (*Handbook* and Index) are relatively high, indicating predominance of speed factors; of intermediate size with the maximal steps and the two running scores (Drop-off and Ratio) in which no arbitrary adjournment was made for speed; and lowest with the Brouha test. The duration of the 200-yard run makes the use of any scores derived from it of doubtful value in assessing the runner's tolerance for exercise of an endurance nature. The Brouha and maximal steps exercises however were of sufficient duration to induce to some extent at least physiological mechanisms involved in long-continued work.

The combined O_2 supply measure is developed from two components, one of which is theoretically closely related with capacity for a high level of aerobic work, i.e., of endurance and the other with a high level of anaerobic work. The contribution is approximately equal from the two components. On the assumption that the combined O_2 supply is a valid criterion of total exercise tolerance, the *Handbook* score is the most acceptable of the performance measures studied, followed closely by maximal steps, then by time on the 200-yard run. The Ratio and Drop-off methods of scoring are the least acceptable, their correlations with the criterion being less than that of the 50-yard run. The Brouha test and the C Index show an equivalent degree of correlation with the criterion and are of intermediate acceptability.

The importance of determining the extent to which speed and endurance factors are separable has been stressed by Henry and Kleeberger.[13] For individuals such as were used in this study, it seems quite possible that speed and endurance factors are inseparable. None of the subjects had ever been specifically trained in any running event. The anatomical, physiological, and psychological qualities of an individual which make a high degree of speed possible may very conceivably be the same ones which would lead her to develop capacity for sustained effort or endurance. For example, neuromuscular coordination would lead to kinesthetic satisfactions and to successful performance in the speed events; these in turn would lead to increased interest and participation with resulting strength, capacity for O_2 transport, willingness to undergo discomfort, recognition of the true endpoint of exhaustion, and practice in reaching it.

Our complete confidence in the cooperation of the subjects in working to what was to them the limit of their ability was stated earlier and is again emphasized. Our confidence that the true endpoint of exhaustion was reached in the maximal steps or the Brouha test (for those subjects not continuing for the full four minutes in

the latter) or that true maximal speed was attained in the runs is considerably less. Probably few if any of the subjects had ever reached or had any conception of the degree of effort or the sensations associated with all-out exhausting performance characteristic of trained sprinters, distance runners, or participants in highly competitive athletics, heavy industry, or a struggle for self-preservation. Whether the experience of such effort, either occasional or habitual, is necessary or desirable is not relevant to the present discussion. To us, it becomes increasingly clear that with relatively untrained subjects, measures of exercise tolerance based upon voluntary maximal performance are not and cannot be measures of true capacity.

Few of the relationships found between the performance measures and the criterion physiological measure on the one hand, and the other physiological measures on the other are of statistical significance. Lability and sensitivity of the physiological measures may be an important influence in the low correlations found. It must be kept in mind that the number of individuals studied was small. The respiratory measures, especially the Ventilation Index, seem most significant and are being investigated further. The relationships between post-exercise physiological adjustments, including *rate* of recovery of the heart rate and of O_2 consumption, and the performance and combined O_2 supply measures are also being studied. That localization of fatigue in the leg muscles was a limiting factor in the performance tests is possible. Evaluation of the importance of leg strength in performance was considered but the lack of reliable methods of measurement preclude any comment of merit. This phase of the problem needs further study.

SUMMARY

1. Performance in the Brouha Step Test, maximal stool stepping, and on runs of 50 and 200 yards scored in several ways was compared with physiological responses to maximal and submaximal work.

2. The subjects were college women majoring in physical education and women teachers of physical education, none of whom was or ever had been in a highly "trained" state.

3. A criterion measure of combined O_2 supply was developed based upon the maximal O_2 debt tolerated and upon the proportion of total O_2 cost of a standard, submaximal exercise utilized during the exercise period.

4. Physiological responses associated with maximal work showed practically no significant relation to performance or the O_2 supply criterion.

5. The relationships found between (1) heart rate and O_2 pulse associated with submaximal work, and (2) the combined O_2 supply and performance measures are slight, and from the results of this study alone would merit little consideration.

6. The relationships between (1) Ventilation Index associated with submaximal work, and to a lesser extent the Ventilation Equivalent and pulmonary ventilation, and (2) the performance and O_2 supply measures warrant further study.

7. Correlations between combined O_2 supply and the several performance measures are highest for the *Handbook* score, and maximal steps, lowest for the Run Ratio and Run Drop-off. A new index, called "C" index, adjusting the score assigned a given Run Ratio for varying speed on the short run, had a higher correlation with the physiological criterion than the Run Ratio, but somewhat lower than that of the *Handbook*. The C Index has the advantage over the *Handbook* score of being adaptable to a wide range of data observed under varying conditions.

8. The difficulty of separating speed and endurance factors and of obtaining truly maximal performance from untrained subjects was discussed briefly.

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Research Abstracts

PREPARED FOR THE NATIONAL COUNCIL OF THE RESEARCH SECTION
By GRANVILLE B. JOHNSON

PHYSICAL ANTHROPOLOGY

Seltzer, Carl C., "Chest Circumference Changes As a Result of Severe Physical Training," *Am. J. Phys. Anthrop.* (ns), 4:3, September.

The effect of a severe physical training period on chest circumference measurements was studied in the case of 272 aviation cadets. The results showed a general increase of the chest circumference as a result of the training period. This was not considered to be a reflection of any skeletal modifications, but due rather to a greater development of the thoracic musculature and increased tonus of these muscles. Gain in chest circumference was evidently no criterion of improved physical fitness.—*The Wistar Institute.*

Renes, Rijnier C., "Symmetrical and Asymmetrical Occurrence of Papillary Patterns," *Am. J. Phys. Anthrop.* (ns), 4:2, June.

From an investigation concerning the occurrence of symmetrical and asymmetrical combinations of pattern types on fingers the following results have been obtained. There is no tendency to asymmetrical occurrence of papillary patterns but on the contrary a tendency to repulsion between patterns of different types. This tendency is not influenced by race and sex. For arch-loop and loop-whorl combinations this tendency proved to have a constant value; for arch-whorl combinations this constancy has not been proved but it is quite probable. The tendency to repulsion between loops and arches proved to be weakest; that between loops and whorls is stronger, whereas that between arches and whorls is so strong as nearly always to prevent the occurrence of this combination. It is possible to calculate the percentages of all symmetrical and asymmetrical combinations of papillary patterns in a certain population group if the percentile occurrences of the three types of patterns in the individual digits are known. The phenomenon of symmetrical occurrence of papillary patterns is not primary but caused by the tendency to repulsion.—*The Wistar Institute.*

Pellar, Sigismund, "A New Rule For Predicting The Occurrence of Multiple Births," *Am. J. Phys. Anthrop.* (ns), 4:2, March.

A new rule is proposed amplifying that of Hellin-Zeleny. The rule is expressed in the geometrical series m, mp, mp^2, mp^3, mp^4, where m is the number of fertile women of whom one has born twins, and p is the product of m and c, the latter standing for the average number of children per mother. Multiplying each term of the series by c, we derive Hellin-Zeleny's rule ($1:n$, $1:n^2$, . . . , . $1:n^5$) with n slightly modified to the value p. If p exceeds n by no more than 4%, the discrepancies between expectation according to Hellin-Zelany and the actual number of triplets and quadruplets in U. S. for 1939-1940 disappear. Multiplying any term of the series m, mp, . . . mp^4 by itself gives the expected incidence of mothers with repeated multiple births of the same litter size. Multiplying any two or three terms of the series with one another gives the estimated frequency of mothers with a combination of the respective multiple births of different litter size. Usually one in 20 to 25 fertile women has been the mother of twins, the extreme values being 14 to 33 women. These variations are accounted for by factors of race, geography, physical fitness, fluctuations of reproductive activity, and the age distribution of pregnant women. A table is presented showing the order and frequency of multiple births and their combinations as predicted by the new rule.—*The Wistar Institute.*

PHYSIOLOGY

Andrew, Warren, "Age Changes in the Vascular Architecture and Cell Content in the Spleens of 100 Wistar Institute Rats, Including Comparisons With Human Material," *Am. J. Anat.*, 79:1, July.

Spleens of rats, ranging in age from 21 days to 1,170 days, have been studied. In the youngest animals the malpighian follicles are not yet completely formed. In animals of 50 days the follicles are well formed. Reaction centers are present and persist from this time up through middle age. The processes of lymphocyte degeneration and phagocytosis are prominent in them. In senile animals (800-1,170 days) these centers are lacking. The red pulp differs from that of younger rats. The compact reticular type of pulp of younger forms is replaced by a tissue in which sinusoids appear to occupy most of the volume of the pulp. This change appears to be brought about by actual transformation of fibroblasts to endothelial cells lining newly formed channels. The red pulp of senile forms shows more plasma cells and more pycnotic lymphocyte nuclei. Human material shows certain age changes similar to those seen in the rat. *The Wistar Institute.*

Schwarz, Emil, "Cellular Gigantism and Pluripolar Mitosis in Human Hematopoiesis," *Am. J. Anat.*, 79:1, July.

Giant erythrocytes and giant leucocytes are exceptional findings in human blood and bone marrow. They are independent of type or morbid condition of hemotopoiesis. These giant cells originate from bivalent ancestors formed by karyokinesis without cytokinesis, which carry two nuclei and two sets of centricles. Repetition of this mechanism results in pluripolar mitosis and plurinucleated giant erythroblasts. These cells represent true gigantism, not hypertrophy. Segmentation in pluripolar mitosis is rarely total, frequently partial or absent. Cytokinesis is often delayed and resumed after the telophase. This recovery and the isolated, asystematic occurrence of gigantism suggest that a localized extracellular and temporary agent is responsible for the inhibition. The nature of this factor remains obscure. Pluripolar mitosis never increases the issue but at most makes up, in the case of total segmentation, for the loss of progeny in former generations. Gigantism does not interfere with nuclear maturation, or with the production of hemoglobin or the specific granules or leucocytes. Denucleation transforms the giant erythroblast into a gigantocyte, the dimensions of which (18-45 μ) vary directly with the rank plurinucearity. Large plurivalent erythroblasts may also result from interrupted mitosis. Several types of this disorder are described. Exaggerated growth tendency gives rise to univalent erythroblasts and large erythrocytes but not to isolated gigantism. *The Wistar Institute.*

Sunderland, Sydney, "Metrical and Non-metrical Features of the Muscular Branches of the Radial Nerve," *J. Comp. Neur.*, 85:1, August.

This paper records the results of an investigation of the shortest and longest distances to individual muscles supplied by the radial nerve which have been ascertained in twenty specimens by measurement along the nerve and its branches from a fixed point. This is a necessary preliminary to a study of the order and rate of regeneration following lesions of this nerve. The serial order of innervation of the muscles has been determined by a study of the shortest distances to each and is, in general, brachioradialis, extensor carpi radialis longus, extensor carpi radialis brevis, extensor digitorum communis, extensor carpi ulnaris, abductor pollicis longus, extensor digiti quinti, extensor pollicis longus, extensor pollicis brevis, extensor indicis proprius. Departures from this order are common and information relating to the observed variations is provided.—*The Wistar Institute.*

Lachman, Ernest, "Is the Concept of the 'Anatomical Position' Still Tenable? A Contribution to the Subject of Anatomical Nomenclature," *Anat. Rec.*, 95:2, June.

Objections to the concept of the "anatomical position" so far have been raised mainly by comparative anatomists, embryologists, and teaching clinicians. They point to the possible confusion in the use of such misleading terms as "anterior," "posterior," "superior," and "inferior" which are predicated on this concept. This paper calls attention to important contradictions in our teaching of topographic anatomy which can be attributed to the retention of the concept. While in the words of Cunningham "all topographical descriptions are framed on the anatomical convention that the body is in the erect position," actually they are based on the study of the supine cadaver. Yet x-ray investigations reveal that the location of most of the abdominal and thoracic organs in the erect individual differs considerably from the position assumed by these viscera in the horizontal. It is therefore recommended that the concept of the "anatomical position" and the use of qualifying directional terms be discarded at least until enough radiographic data on the erect living subject are available to revise our teaching of topographic anatomy.—*The Wistar Institute.*

Emory, Louis, "Method of Duplicating Anatomical Specimens,"*Anat. Rec.*, 95:2, June.

Duplication of an intricate anatomic specimen, such as the skull, has been simplified by a special process devised by Captain Louis Emory of the Army Dental Corps.

So-Lo-Go-Ma, an ammoniacal liquid latex solution is painted, in thin coats, onto the specimen, the recessed areas of which have been blocked with wax, each coat is allowed to cure, then a thick coat of adhesive plastic material about one-half inch thick is applied. Further reinforcement, when required, consists of plaster, strips of burlap, or sheets of gauze incorporated into the plastic material. Artificial stone of a creamy consistence is poured into the latex mold to form the model which may be solid like a mandible, or hollow like a skull. The models are frequently mistaken for the specimen. They are permanent, durable, and many may be made from one mold. Wartime lack of anatomic specimens resulted in the use of such models at the Medical, X-ray, and Dental Sections of the Medical Department Enlisted Technicians' School at Billings General Hospital.—*The Wistar Institute.*

Friedman, Sydney M., "The Position and Mobility of the Duodenum in the Living Subject," *Am. J. Anat.*, 79:1, July.

Serial roentgenograms of approximately 450 hospital patients with normal alimentary tracts were studied for position of the duodenum. The mean position of the highest point of the first part of the duodenum is opposite the lower part of L2, varying between T12 and L3. Part of the variation is due to a downward migration with age of the duodenal high point at a statistical rate of about half of a vertebra per decade. The mean position of the lowest point of the third part of the duodenum does not migrate downwards with age so that there is a constant tendency towards shortening of the vertical diameter of the duodenal curve as age advances. The most fixed point is the duodeno-jejunal flexure opposite L2 $\pm$ 1 vertebra. It does not migrate with age. Depending on the state of fullness of the stomach and intestine, postural changes may induce an excursion of the duodenum of about $\pm$ 2 vertebrae. Downward excursions occur about the duodeno-jejunal flexure as fixed pivot, with consequent shortening of the vertical duodenal diameter. Upward excursions involve the whole duodenum including the duodeno-jejunal flexure.—*The Wistar Institute.*

Lanier, Patricia F., and Mildred Trotter, "The Volume of the Sacral Canal," *Am. J. Phys. Anthrop.* (ns), 4:2, June.

Variation in the volume of the sacral canal may be one anatomical factor contributing to variation in the level reached by a given dose of anesthetic in continuous caudal analgesia. Four hundred sacra comprising 100 each of males and females in the negro and white races were studied for volume of the canal. The canal was filled with shot after the foramina had been closed and certain ligaments simulated with adhesive tape. The measured volume is significantly greater in each of the white sexes then in the corresponding six of the negro race; likewise, the males of each race have a significantly greater volume than do the females. Of those sacra with fused coccyges the volume of the canal is significantly greater when the base of the sacral hiatus lies on the coccyx than when it lies on the sacrum. There is no direct correlation between the stature of the individual and the volume of the sacral canal.—*The Wistar Institute.*

Michelson, Nicholas, "A Method for Assessing the Development of the Hand Skeleton," *Am. J. Phys. Anthrop.* (ns), 4:2, June.

A method is offered for the evaluation of progressive maturation of the bones of the hand. By using roentgenograms criteria were formulated for the recognition of twenty-two presumably equidistant developmental stages beginning with the pre-epiphysial state and ending with complete bone maturation.

The classificatory system is based on the following criteria: (1) The presence or absence of an epiphysis; (2) the extent of the gap between diaphysis and epiphysis; (3) the ratio between the width of diaphysis and epiphysis; (4) the appearance of a serrated edge at the base of the diaphysis and epiphysis follows; (5) the morphological type of the calcification between diaphysis and epiphysis; (6) the ratio between the width of the calcification where it actually contacts the epiphysis, and the width of the epiphysis; (7) the extent of resorption of the calcification between diaphysis and epiphysis; and (8) the extent of resorption of intra-epiphysial opacities. The last two criteria apply of course, to the later stages of ossification.—*The Wistar Institute.*

Sunderland, Sydney, "The Innervation of the First Dorsal Interosseous Muscle of the Hand," *Anat. Rec.*, 95:1, May.

It has been established, by dissection and from a study of suitable peripheral nerve injuries, that the first dorsal interosseous muscle of the hand may be completely or partially innervated by the median nerve. In one specimen fibers of an undertermined type were traced by dissection from the superficial radial nerve into the muscle. The anomalous innervation of the first dorsal interosseous muscle should be kept in mind when estimating the state of conduction in injuries of the ulnar nerve on the basis of contraction of this muscle. —*The Wistar Institute.*

Shanklin, William M., "The Development and Histology of Pituitary Concretions in Man," *Anat. Rec.*, 94:4, April.

Concretions were observed in four of the eight adult females and five of the males. None were found in normal pituitaries of seven children ranging from the newborn to 15 years. These concretions were found inside the neurohypophysis and in the subarachnoid space overlying the upper surface of the infundibular process. Those in the subarachnoid space are derived from mesothelium. Some areas of the mesothelium become hyperplastic. Following this the nucleus and cytoplasm of one of the cells becomes enlarged. Later both nuclear material and cytoplasm are replaced by hyaline material. The neighboring mesothelial cells next become oriented around the enlarged cells and

from a continuous membrane. Following this additional lamellae of hyaline material and membranes are formed. The older concretions are surrounded by a thick capsule of collagenous fibers containing a few nuclei that appear to belong to fibroblasts. The cells of origin of these concretions inside the pituitary were not determined; however, the histology of those inside and those outside was the same. Many of the concretions show degenerative changes involving the original cell nucleus and cytoplasm as well as the interlamellar membranes. In the later stages of senescence the entire concretion, including the connective tissue capsule, undergoes a "melting down."—*The Wistar Institute.*

NUTRITION

Hathaway, Millicent L., and Juniata E. Strom, "A Comparison of Thiamine Synthesis and Excretion in Human Subjects on Synthetic and Natural Diets," *J. Nutrition*, 32:1, July.

Three normal women were maintained on a synthetic diet containing 1.00 mg. of thiamine per day for 7 weeks. The diet was followed, after a month's respite, by a diet of natural foods containing 0.84 mg. of thiamine per day. The urinary thiamine excretions averaged 113 to 147 mg. on the synthetic diet, and 90 to 112 mg. on the natural diet. The fecal excretions of "free" thiamine averaged 13 to 17 mg. and 25 to 40 mg. on the two diets. The "combined" thiamine values on the diet of natural foods were 2.4 to 5.1 times greater than on the synthetic diet. These results might indicate that the conditions were less favorable for fecal synthesis of thiamine on the synthetic than on the natural diet, and that in these subjects fecal synthesis is not an important factor in thiamine economy. No symptoms of deficiency were evident in any of these subjects on either level of thiamine intake. The results of the study support the evidence of other workers that the lowering of the recommended daily allowance of thiamine for women to 1.1 or 1.2 mg. per day allows an adequate margin of safety.—*The Wistar Institute.*

———————, and Dorothy E. Lobb, "A Comparison of Riboflavin Synthesis and Excretion in Human Subjects on Synthetic and Natural Diets," *J. Nutrition*, 32:1, July.

Three normal women were maintained for 7 weeks on a synthetic diet containing 1.09 mg. of riboflavin per day. This diet was followed after a month's respite, by a diet of natural foods containing 1.33 mg. of riboflavin. Throughout the study 24-hour urinary excretions of riboflavin were determined and during 2 weeks of the time on the synthetic diet, 1-hour fasting excretions were also measured. Fecal riboflavin excretions were measured by 5-day periods. The daily urinary riboflavin values averaged 165, 152, and 161 μg during the last six 5-day periods on the synthetic diet, and 174, 229, and 210 μg on the diet of natural foods. The 1-hour fasting urinary excretions varied from 3.7 to 10.9 μg, with average values for the three subjects of 5.9, 7.1, and 7.8 μg. Evidence is presented to refute the suggestion that urinary riboflavin excretion is related to urinary volume. Fecal excretions on the diet of natural foods were 3.7 to 3.8 times greater than on the synthetic diet. For two subjects the total excretions exceeded the riboflavin intakes during the period on the natural diet.—*The Wistar Institute.*

Deuel, Harry J., Jr., "Studies on the Comparative Nutritive Value of Fats. IX. The Digestibility of Margarine Fat in Human Subjects," *J. Nutrition*, 32:1, July.

The average value of seven tests for the coefficient of digestibility of modern commercial margarine fat (characterized as being made from domestic oils and having a m.p. of 94-95° F.) was 97 which was identical with the mean for

three tests with butter. The experiments on margarine fat were made on three men and four women while those on butter were carried out on two men and one woman. All were laboratory assistants or students. The average margarine intake was 260 gm for the 3-day experimental period with a maximum of 111 gm per day. No unpleasant physiological effects were noted. It is concluded that from the standpoint of digestibility, margarine can be considered to contain a fat of high nutritive value.—*The Wistar Institute.*

Robertson, Elizabeth C., and Alonzo L. Morgan, "The Effects of Added Vitamin A on the Conjunctiva and the Level of Vitamin A in the Blood," *J. Nutrition*, 31:4, April.

Twenty pupil nurses, receiving a good diet were given in addition 50,000 I.U. of vitamin A per day. Twenty controls, closely comparable as judged by conjunctival elevations and degree of transparency of their conjunctivae on slit-lamp examination were given placebos. Most were on therapy for 2 years.

Besides a detailed examination of the conjuntivae and the surrounding tissues with the naked eye, a large drawing of the slit-lamp view of the non-movable, deep conjunctival blood vessels, which are presumably attached to the outer surface of the sclera, was made on each subject every 2 months. At each examination this required three-quarters of an hour for each patient. Any change in elevations, the number of the deep blood vessels and the ease with which they could be seen was observed and recorded. Even after 2 years therapy it was impossible to differentiate between those receiving vitamin A therapy and the controls by slit-lamp examination. Life-size Kodachrome photographs taken every 6 months were of little value because of differences in color tone. Very little, if any, change was evident in the blood vitamin A level even after 22 months of therapy.—*The Wistar Institute.*

Steggerda, Frederic R., and Harold H. Mitchell, "Variability in the Calcium Metabolism and Calcium Requirements of Adult Human Subjects," *J. Nutrition*, 31:4, April.

The results of calcium metabolism studies on 19 men, designed to study the utilization of the calcium in diets containing milk products or calcium salts, and the daily requirements of calcium, are reported. The data appear to support the following conclusions:

1. The calcium of the experimental diets was on the average utilized to the extent of about 32% in the prevention of endogenous losses. The coefficient of variation of this average value is 23.3%.

2. The heating of milk to 160° F. for 30 minutes, the homogenization of milk, the addition of sodium alginate, citric acid or citrates in moderate amounts, the preparation of a soft curd milk by base-exchange, produced no demonstrated change in the utilization of its content of calcium.

3. The average calcium requirement of the adult human indicated by these experiments is 9.21 mg per kg of body weight, with a coefficient of variation of 29.4.

4. In conjunction with other experiments of similar nature, involving a total of 43 subjects, a good average value for the calcium requirement of adult men and women of a nutritional status representative of college students and staff members, subsisting on diets containing dairy products to furnish from one-half to two-thirds of a calcium content, is 10 mg per kg of body weight per day. This average is associated with a coefficient of variation of 22 ± 1.7. *The Wistar Institute.*

Gifft, Helen H., and Hazel M. Hauch, "A Comparison of Four Methods For Studying the Urinary Excretion of Thiamine," *J. Nutrition*, 31:5, May.

Four normal adults were maintained for 44 days on a controlled diet which

was estimated to furnish 600 μg of thiamine per 1000 cal. Basal 24-hour urinary excretions of thiamine were higher at the first of the period than at the end. Supplements of thiamine given during the pre-experimental period undoubtedly caused elevations in values for the first 2 weeks of the study.

Four urinary excretion tests were used as criteria of nutrition with respect to thiamine. Values for 24-hour excretions of thiamine for the last 4 weeks ranged from 100 to 224 μg per day. Average percentages of thiamine intake excreted ranged from 9 to 13. Responses to a 5-mg oral test dose at the end of the study ranged from 15 to 22 recovery in 24 hours. Responses to 1-mg intramuscular test doses toward the beginning of the study ranged from 15 to 24 recovery. At the end of the study they ranged from 8 to 21 recovery, or 193 to 403 μg excretion in 24 hours. When the urinary excretion values recorded for "normal" subjects were used as standards for comparison, the nutritional status of these subjects with respect to thiamine was not judged to be the same by all four criteria. More data are needed to establish the range of normal values for these urinary excretion tests, and their relative sensitivity. —*The Wistar Institute.*

Haldi, John, and Winfrey Wynn, "Observations on Efficiency of Swimmers as Related to Some Changes in Pre-exercise Nutriment," *J. Nutrition*, 31:5, May.

Experiments on twelve swimmers showed that the time required to swim each of three laps in a 100-yard sprint was the same after a heavy meal as after a light meal eaten 2½ to 3 hours before swimming. Supplementation of the light meal by the ingestion of 50 or 100 gm sucrose 1 hour before swimming had no effect on swimming time. The drop-off in the second and third laps, which is taken as an index of fatigue, was the same regardless of the amount of food intake before swimming. It is concluded that the amount of food eaten several hours before swimming a 100-yard sprint had no effect on initial speed or fatigue.

The blood sugar concentration immediately after swimming was the same in all the experiments regardless of the food intake.—*The Wistar Institute.*

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THE Editorial Committee has approved the following policies for the publication of material in the *Quarterly:*

1. Manuscripts should be sent to the Editor who will see that each one is read by at least two members of the Board of Associate Editors. The Editor will advise the author as to the suitability of the paper or the desirability for revision.

2. Papers are not judged by arbitrary standards of length but on their content of new research results in the field of physical education, health education, and recreation, presented with the greatest brevity compatible with scientific accuracy and clarity.

3. Since manuscripts will not be insured against loss or damage, authors are expected to retain duplicate copies of all material submitted.

4. An original typewritten copy of the manuscript should be submitted. The content should be double spaced with a margin of 1½ inches on each side.

5. The author may include either a list of references at the end of the article or he may put them in footnotes or these two methods may be combined. Book publishers and periodicals do not always agree on the exact order of details in the preparation of references. Also, authors do not always include all the necessary information in references. For authors who have not published extensively a simplified form of magazine and book reference is shown. If a formal bibliography is included with the paper a simple footnote may be used as shown:[1]

1 Katherine B. Crisp, *Health for You*, p. 520.

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2 Stern, Francis. *Applied Dietetics.* Baltimore, Md.: Williams and Wilkins Co., 1943. (form for book reference in a bibliography)

3 Corbin, H. D., "Current Problems in Recreation," *Journal of Health and Physical Education,* 15:6 (June, 1944). (form for magazine reference in a bibliography)

Note that the main items in a book reference are set off by periods while those in a magazine reference are set off by commas. These two types of references may be combined in what are called bibliographical footnotes which are placed on the corresponding pages as the article progresses. These are set up exactly as footnotes 2 and 3 except that page numbers are added at the end and, in this case, it is not necessary to put the author's last name first.

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4 Kraines, S. H., and E. S. Thetford. *Managing Your Mind.* New York: The Macmillan Co., 1944.

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There are many sources of information relative to the preparation of manuscripts for publication. A good source is *A Manual of Style* (10th Edition), Chicago, University of Chicago Press, 1937.

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